Application for
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Of

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EQUIPMENT FOR THE CALCULATION OF MOBILE HANDSET POSITION

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MOBILE HANDSET POSITION

BACKGROUND OF THE INVENTION

The present invention relates to equipment for locating a current position of a mobile handset by using a radio signal.

5   JP-A-7-181242 discloses a method for calculating a present position of a mobile handset by using a signal of a cellular telephone. The method of locating the current position of a mobile handset as disclosed in this official gazette will be described

10 below. The mobile handset receives signals transmitted from three cellular telephone base stations. Based on the received signals, the mobile handset calculates differences in propagation time among the signals from the three base stations. The mobile handset, using the

15 propagation time differences, calculates the current position according to triangulation.

SUMMARY OF THE INVENTION

In areas very close to cellular phone base stations or in suburbs or mountainous regions where

20 cellular phone base stations are few, the number of cellular phone base stations that satisfy a reception quality allowing a position measuring operation at the position of the mobile handset decreases. As a result, the number of base stations that satisfy the reception

quality usable for position calculation becomes fewer than three, making it impossible to use signals from at least three base stations required for position calculation. This renders the locating of the current

5 position of the mobile handset impossible with a conventional method using trilateration. Therefore, in areas where signals from only two or less base stations are available for position calculation, services using the position information cannot be provided.

10 To solve the problem described above, one aspect of the present invention provides an equipment for calculating the mobile handset position which calculates the number of base stations available for position calculation, performs the position calculation

15 based on trilateration when the number of base stations is three or more, performs the position calculation by using a two-station-based position calculation method when the number of base stations is two, and performs the position calculation by using a one-station-based

20 position calculation method when the number of base stations is one. According to another aspect of the present invention, the equipment controls information to be provided to the mobile handset holder according to the number of base stations available for position

25 calculation.

A more detailed description of the position calculation method will be given later. These processing and calculations may be executed by a

processor based on software or by dedicated hardware. The scope of the present invention includes procedures themselves detailed later with reference to the accompanying drawings, and hardware and software for

5   the procedures.

Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

10   BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a configuration of equipment implementing the present invention.

Fig. 2 is an operation flow of a position
15   calculation unit 400.

Fig. 3 illustrates a first example configuration realizing a position calculation step for two base stations 421.

Fig. 4 illustrates a second example
20   configuration realizing the position calculation step for two base stations 421.

Fig. 5 illustrates a third example configuration realizing the position calculation step for two base stations 421.

25   Fig. 6 illustrates a first example embodiment realizing a position calculation step for a single base station 431.

Fig. 7 illustrates a second example configuration realizing the position calculation step for a single base station 431.

Fig. 8 illustrates an operation of a position
5 information application unit 500.

DETAILED DESCRIPTION OF THE EMBODIMENTS

A configuration of the equipment implementing the present invention is shown in Fig. 1. A signal receiver 101 performs reception processing at a
10 high/intermediate frequency corresponding to a cellular signal received by an antenna 100 and also demodulation processing on a base band signal to generate a cellular reception signal 102.

A position calculation information generator
15 103 generates, from the cellular reception signal 102, position calculation information 104 necessary for position calculation and outputs it to a base station selection unit 105. The information required for position calculation includes, for example, a reception
20 timing of the cellular signal from base stations and a reception quality of the cellular signal from base stations. The reception timing may be determined, for example, by using a matched filter and producing a delay profile of the received signal. The reception
25 quality of the cellular signal may be determined from a correlation value of the delay profile.

According to the position calculation

information 104 received, the base station selection

unit 105 selects base stations available for the

position calculation and outputs position calculation

information 106 on the selected base stations to a base

5   station number counter 200 and the position calculation

unit 400. For example, the method of selecting the

base stations may select only those base stations whose

signal-to-noise ratios of the received signals are in

excess of a predetermined threshold.

10   The base station number counter 200 counts

the number of base stations selected by the base

station selection unit 105 and outputs the selected

number of base stations 201 to a position calculation

method controller 300.

15   The position calculation method controller

300 outputs to the position calculation unit 400 and a

position information application unit 500 a control

signal 301 that controls, according to the selected

number of base stations 201, the position calculation

20   method to be performed by the position calculation unit

400. In this embodiment, when the selected number of

base stations 201 is one, the control signal 301 is set

to 1; when the base station number is two, the control

signal 301 is set to 2; and when the number is three or

25   more, the control signal 301 is set to 3.

        The position calculation unit 400 selects the

position calculation method according to the control

signal 301, calculates the current position of a mobile

handset by using the position calculation information
106 on the base stations selected by the base station
selection unit 105, and outputs a position calculation
result 401.   The operation flow of the position

5 calculation unit 400 will be explained by referring to
Fig. 2.   The position calculation unit 400 checks if
the control signal 301 is "3" or not (step 410).   If
the control signal 301 is "3", the position calculation
unit 400 performs the position calculation based on

10 trilateration (step 411).   When the control signal 301
is not "3", the position calculation unit 400 checks
whether the control signal 301 is "2" (step 420).   If
the control signal 301 is "2", the position calculation
unit 400 performs the position calculation according to

15 a 2-station-based position calculation method (step
421).   When the step 420 finds that the control signal
301 is not "2", i.e., the control signal 301 is "1",
the position calculation unit 400 performs the position
calculation according to a 1-station-based position

20 calculation method (step 431).   The position
calculation unit 400 outputs a position calculation
result 412, 422, 432 as the position calculation result
401 produced by the position calculation method
selected according to the control signal 301 (step

25 440).

Fig. 3 shows a first example configuration of
the 2-station-based position calculation step 421.   In
this example, of the position calculation information

106 on the base stations selected by the base station
selection unit 105, first and second base station
positions (X_1, Y_1) and (X_2, Y_2) are used for position
calculation. A base station positions averaging unit

5 600 calculates X and Y component averages of (X_1, Y_1)
and (X_2, Y_2) and outputs them as a mobile handset
position (X, Y).

Fig. 4 shows a second example configuration
of the 2-station-based position calculation step 421.

10 In this example, of the position calculation
information 106 on the base stations selected by the
base station selection unit 105, first and second base
station positions (X_1, Y_1) and (X_2, Y_2) and reception
qualities of signals received from the first and second

15 base stations, W_1, W_2, are used for position
calculation. In this embodiment, a signal-to-noise
ratio SNR is used as the reception quality of the
received signal. As another reception quality a
reception power of the received signal may be used.

20 The base station positions averaging unit 600
calculates weighted averages from the X and Y
components of (X_1, Y_1) and (X_2, Y_2) with the reception
qualities W_1 and W_2 taken as weights and outputs a
mobile handset position (X, Y).

25 Fig. 5 shows a third example configuration of
the 2-station-based position calculation step 421. The
position calculation information 106 on the base
stations selected by the base station selection unit

105 is input to a trilateration operation unit 602 and
a base station information storage 603. The base
station information storage 603 holds position
calculation information used in the past position

5   calculations. In this example, the base stations
selected by the base station selection unit 105 are two
stations, a first base station and a second base
station, which is one station short of the requirement
for trilateration. Hence, the base station information

10 storage 603 selects position calculation information
604 on a third base station, different from the first
and second base stations, from among the position
calculation information used in the past position
calculations, and outputs the selected information to

15 the trilateration operation unit 602. The method for
selecting the third base station, for example, needs
only to select a base station different from the first
and second base stations from among the base stations
used in the latest position calculation. When there

20 are two or more such base stations, one with the best
reception quality may be chosen. The trilateration
operation unit uses the position calculation
information on the first and second base stations
entered from the base station selection unit 105 and

25 the position calculation information on the third base
station entered from the base station information
storage 603 to perform the position calculation based
on the principle of trilateration and then outputs a

mobile handset position 422.

Fig. 6 shows a first example configuration of the 1-station-based position calculation step 431. In this example, of the position calculation information

5   106 on the first base station selected by the base station selection unit 105, the first base station position (X_1, Y_1) is used for the position calculation. A base station position output unit 700 outputs the position (X_1, Y_1) as the mobile handset position (X, Y).

10   Fig. 7 shows a second example configuration of the 1-station-based position calculation step 431. The position calculation information 106 on the base station selected by the base station selection unit 105 is entered into a trilateration operation unit 701 and

15   a base station information storage 702. The base station information storage 702 holds position calculation information used in the past position calculations. In this embodiment, the base station selected by the base station selection unit 105 is only

20   one station, a first base station, which is two stations short of the requirement for trilateration. Hence, the base station information storage 702 selects position calculation information 703 on the second and third base stations, different from the first base

25   station, from among the position calculation information used in the past position calculations and then outputs the selected information to the trilateration operation unit 701. The method for

selecting the second and third base stations, for example, needs only to select two base stations different from the first base station from among the base stations used in the latest position calculation.

5 When there are two or more such base stations, two with the best reception qualities may be chosen. The trilateration operation unit uses the position calculation information on the first base station entered from the base station selection unit 105 and

10 the position calculation information on the second and third base stations entered from the base station information storage 702 to perform the position calculation based on the principle of trilateration and then outputs a mobile handset position 432.

15   The position information application unit 500 uses the received position calculation result 401 and control signal 301 to provide a mobile handset holder with services using position information, such as offering nearby store information and route guidance.

20   Fig. 8 shows an operation of the position information application unit 500 when it provides the nearby store information as the service using position information. It is assumed that the position calculation result 401 represents a position 800 as a

25 current position. First, a case where the control signal 301 is "3" will be explained. In this case, the number of base stations used in the position calculation is three or more and the accuracy of the

position calculation result 401 is considered good.
The position information application unit 500 provides
the mobile handset holder with information on stores
810 and 811 in an area 801 as the nearby store

5 information. Next, a case in which the control signal
301 is "2" will be explained. In this case, the number
of base stations used in the position calculation is
two and the accuracy of the position calculation result
401 is considered worse than that when the control

10 signal 301 is "3". In this case, the position
information application unit 500 provides the mobile
handset holder with information on stores 810, 811 and
812 in an area 802 wider than the area 801 as the
nearby store information. Finally, a case where the

15 control signal 301 is "1" will be explained. In this
case the number of base stations used in the position
calculation is one and the accuracy of the position
calculation result 401 is considered still worse than
when the control signal 301 is "2". The position

20 information application unit 500 provides the mobile
handset holder with information on stores 810, 811, 812
and 813 in an area 803 wider than the area 802 as the
nearby store information.

As described above, even when the position
25 locating accuracy is poor, the position information
application unit 500 can provide the mobile handset
holder with the nearby store information by controlling
the area for the store information being provided

according to the position locating accuracy.

With this invention, even in areas where signals from only two or less base stations are available for the position calculation, the current

5 position of the mobile handset can be determined. This makes it possible to expand the area of the position information service. Further, by controlling the information to be provided to the user according to the number of base stations used in the position

10 calculation, it is possible to offer useful information to the user even when only one base station is available for the position calculation and the position locating accuracy is bad. The usefulness of the position information service can therefore be enhanced.

15 It should be further understood by those skilled in the art that the foregoing description has been made on embodiments of the invention and that various changes and modifications may be made in the invention without departing from the spirit of the

20 invention and the scope of the appended claims.